The Sutherland Emergency Department

Airway Corner Newsletter

May 2019

	May			Δ April		
Number of intubations	5			4		
Indications	**Trauma**	**Medical:**		**Trauma**	**Medical:**	
	0	ICH/Stroke: 0 Overdose/Ingestion: 2 Sepsis/Resp Failure: 1 Cardiac Failure: 0 Arrest: 2		0	ICH/Stroke: 0 Overdose/Ingestion: 0 Sepsis/Resp Failure:1 Cardiac Failure: 2 Arrest: 1	
Team-leader	**FACEM**	**AT**	**Other**	**FACEM**	**AT**	**Other**
	2	3		4	0	0
Intubator	**FACEM**	**AT**	**Other**	**FACEM**	**AT**	**Other**
	1	1	3	3	1	0

Airway ax performed	Yes 5 / No 0			Yes 2 / No 2		
Checklist utilisation	Yes 3 / No 2			Yes 3 / No 1		
ApOx used	Yes 3 / No 2			Yes 3 / No 2		
Induction rx	**Ketamine**	**Propofol**	**Other**	**Ketamine**	**Propofol**	**Other**
	4	0	1 No agents	2	1	1 No agents
Paralytic rx	**Rocuronium**	**Suxamethonium**		**Rocuronium**	**Suxamethonium**	
	4	0		3	0	
Laryngoscope	**Direct**	**Video**		**Direct**	**Video**	
	0	5		0	4	
First pass success rate	80%			75%		

Intubation manoeuvres	**Nil**	**NPA/OPA**	**BVM**	**LMA**	**Repositioned**	**Cric**	**Nil**	**NPA/OPA**	**BVM**	**LMA**	**Repositioned**	**Cric**
	4	0	0	1	0	0	3	0	1	0	0	0
Desaturation	1						None					
Hypotension	None						None					
Equipment Failure	None						None					
Aspiration	None						None					
Oesophageal intubation	None						None					
Mainstem intubation	None						None					
Laryngospasm	None						None					
Drug error	None						None					
Airway trauma	None						None					
Cardiac arrest	None						None					

Please contact D Gaetani or K Ostrowski should any issues arise regarding airway management within the department

Case Dissection

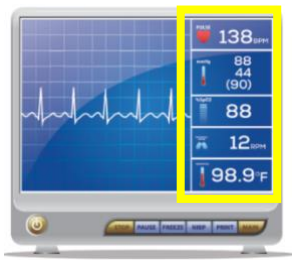
This month there were a few challenging intubations after hours which were handled well. For registrars working at night remember that your friendly anaesthetics, ICU colleagues are often available in the building and can be called upon for assistance. Additionally, there is always an ED consultant on call who is available for advice over the phone and to come in to hospital overnight to assist in departmental flow or managing challenging cases. Don't hesitate to call overnight for assistance or advice in those sorts of situations.

Code Brown Scenario of the Month:
The hypoxic, hypotensive & acidotic septic patient

DISCLAIMER: ***The following section is aimed to raise awareness about a range of techniques available to tackle difficult airway scenarios. They should be considered in consultation with expert airway operators (ED consultants, ICU, Anaesthetics and ENT).***

Modifying the 9 P's of RSI for Patient's with Hypoxia + Hypotension + Acidosis in Sepsis [1-17]

Hefner AC et al (2013) and Kim WY et al (2014) evaluated over 2800 patients requiring emergency intubation. In both trials the rate of cardiac arrest within 10 minutes of intubation ranged from 1.7% – 2.4%. Both trials listed **pre-intubation hypotension (SBP ≤90mmHg) as a risk factor for cardiac arrest**. Hefner et al (2013) also mentioned **hypoxemia as an important risk factor**. Determining the need for, and timing of, intubation requires balancing respiratory and cardiovascular considerations in these fragile patients. The airway manager should optimise conditions to achieve first-pass success, no hypoxia and no hypotension. Therefore, when considering intubation of the hypoxic, hypotensive and acidotic patient, the goal should be to secure a patent and protected airway with no awareness, no pain, no memory, no physiological compromise, while keeping the patient alive.



This has been further described by an American Emergency Physician and airway enthusiast Scott Weingart, who coined the term **'HOP' killers (Haemodynamics, Oxygenation, pH and ventilation)**. Chris Nickson from LITFL developed the **RAPID (Resus inadequate, Acidaemia, PPV, Induction rx, Disease)** mnemonic to remember the causes of peri-intubation hypotension. The mantra **'Resuscitate before you Intubate'** was coined by the American Emergency Physician and airway enthusiast Richard Levitan, who identifies the importance of optimising the patient's positioning, haemodynamics, oxygenation, and pH prior to ED RSI in order to avoid peri and post intubation deterioration. Another term which I really like is **'Resuscitation Sequence Intubation,'** which sums up all of the above, and was developed by Richard Levitan.

With winter coming, I feel that this is an important topic to cover.

Preparation (Equipment, People, Place) [1-17]

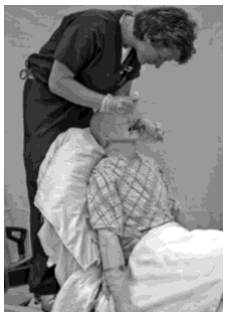
The hypoxic, hypotensive & acidotic patient should be placed in a resuscitation bay with continuous cardiorespiratory monitoring attached. The most senior experienced airway operator should be in control of securing the airway as critically hypoxic patients have a significantly reduced safe apnoea time due to a reduction in FRC, in addition to an increased oxygen consumption rate in the presence of sepsis and shunt physiology. Clinicians should strongly consider placing an arterial line for continuous invasive BP monitoring while preparing for intubation, in order to guide volume resuscitation and closely monitor for deterioration.

Positioning [1-17]

During the pre-oxygenation phase, the hypoxic ***alert*** patient must be placed in their position of comfort. If the patient is ***unresponsive*** or ***apnoeic***, the patient should be placed in the sniffing position with the head of the bed elevated 30 degrees, in preparation for pre-oxygenation and immediate RSI.

During the induction, apnoeic and intubation phases, I would recommend having the patient remain upright to semi-recumbent, in the sniffing position, to avoid losing the alveolar recruitment you have achieved, and prolonging your safe apnoea time (see below). If an optimal view cannot be achieved, assign another team member during the pre-oxygenation phase to be in charge of lowering the head of the bed. The bed should be lowered parallel to the ground as far as possible, and you may need to stand on a stool to get above the patient's head.





Protect c-spine

Not applicable

Pre-oxygenation [1-17]

Hypoxia

In critically unwell patients, the aim of pre-oxygenation should be to achieve maximal haemoglobin saturation (SaO2 >94%) and maximal PaO2. These end-points will usually not be achieved with high flow oxygen alone due to shunt physiology, and the addition of PEEP is essential.

For ***alert, co-operative*** patients, commencing CPAP (FiO2 100% + PEEP 5 – 15 cmH2O, depending on BP) should be strongly considered.

For ***alert*** patients who ***cannot tolerate*** CPAP (e.g. cerebrally agitated secondary to hypoxia), clinicians should strongly consider delayed sequence intubation (DSI) (Administration of IV Ketamine 0.5 – 1mg/kg depending on BP, followed by commencement of CPAP).

In ***apnoeic*** or ***unresponsive*** patients, consider preoxygenation with oropharyngeal airway (OPA) or LMA (reduce gastric insufflation with OPA/LMA, and provide higher airway pressures with LMA) + BVM + PEEP valve. As always, ApOx should be utilised with NP set to 15L/min following administration of a paralytic.

Metabolic acidosis

In severe metabolic acidosis the organic acid production demands an alveolar ventilation requirement that sometimes cannot be met and patients can subsequently develop profound acidemia. These patients usually require a period of NIV and medical optimisation of their underlying condition prior to intubation to avoid severe cardiac dysrhythmias. In the event that patients with severe acidemia require intubation, even a brief apnoeic period can lead to a precipitous drop in pH given the loss of the already inadequate respiratory compensation. Therefore, clinicians should strongly consider continuing ventilation during the apnoeic phase with either BVM or NIV to maintain SpO2 >94% and high minute ventilations (MV) associated with metabolic acidosis. Again, this should be performed with an OPA or LMA in situ, and smaller but regular tidal volumes should be delivered, to avoid gastric insufflation and risk of aspiration.

Pre-treatment [1-17]

Hypotension

Volume resuscitation should commence with 20ml/kg of Hartmann's followed by early administration of inopressors (Noradrenaline or Adrenaline) peripherally via a large bore cannula in the antecubital fossa.

Target a MAP of 100mmHg during the peri-intubation phase to offset the imminent hypotension which will occur with administration of induction agents and commencement of positive pressure ventilation. Insertion of an arterial line prior to intubation should be strongly considered as outlined above.

Plan [1-17]

Although RSI stands for '**RAPID** sequence intubation,' all attempts at rushing should be avoided to ensure that the patient is optimised and that the epiglottis is not overrun. ***SLOW IS SMOOTH & SMOOTH IS FAST***.

Operator: The most experienced clinician in available.

Apnoeic phase: ApOx + Gentle ventilation to maintain high MV. If the patient is receiving NIV, set a back-up rate which matches the patient's MV, leave the mask on with straps disconnected, and remove only once you are about to place the blade in the mouth to maintain oxygenation, ventilation and alveolar recruitment.

Plan A: Video laryngoscopy + Bougie to expedite securing the airway.
Plan B: Second generation LMA.
Plan C: BVM + PEEP + 2 hand technique + OPA + 2x NPA.
Plan D: Front of neck approach.

Paralysis and induction [1-17]

Doses of induction agents and paralytics should be adjusted according to pre-RSI physiology. All induction agents can cause hypotension; hence **DOSING IS MORE IMPORTANT THAN THE AGENT**. In patients with high MV, induction agents which maintain spontaneous respiration should also be considered i.e. Ketamine.

REDUCING THE DOSE OF YOUR INDUCTION AGENT and **INCREASING THE DOSE OF YOUR PARALYTIC AGENT** is required for several reasons: a) Induction agents can drop BP in shock patients by decreasing vascular tone and reducing venous return, b) Some induction agents will decrease sympathetic tone (Benzodiazepines, Propofol), c) Changing patient from negative pressure ventilation to PPV will decrease venous return, d) Paralytics take longer to work in a shock state (cardiac output dependent), and e) Shock by itself is a powerful anaesthetic.

Enter **KETAMINE + ROCURONIUM**. Ketamine should be the induction agent of choice in critically unwell patients as it maintains spontaneous respiration, provides a sympathetic surge and acts as an analgesic. Ketamine should be dosed at 0.5 -1.0 mg/kg IV. Rocuronium dosed at 1.6 – 2.0 mg/kg is considered the paralytic of choice as its onset is comparable to Sux and also provides a longer safe apnoea time.

Placement with proof

Standard of care (waveform capnography and chest radiograph)

Post-intubation care [1-17]

Hypoxia
Following intubation, a lung protective strategy should be commenced on the ventilator (see section below).

Metabolic acidosis
For patients with severe metabolic acidosis, patients with extremely high MV requirements are at high risk of developing relative hypoventilation, flow starvation, patient-ventilator dysynchrony and worsened acidosis, and therefore consider commencing SIMV-PC which will allow the patient to set and maintain their own MV in order to best maintain their respiratory compensation.

Hypotension
Insert an arterial line (if not already done so) and a CVL for ongoing inopressor infusions. Insert an IDC to monitor urine output. Titrate your inopressor to MAP >65 mmHg and urine output >1ml/kg/hr.

SUMMARY

Preparation: Resus bay, Continuous cardiorespiratory monitoring & Invasive arterial monitoring.

Position: Alert = Position of comfort, Unresponsive/Apnoeic = Sniffing position. Consider DSI. Consider intubating upright.

Protect c-spine: Not applicable

Pre-oxygenation: High flow O2 + PEEP + NP for ApOx. Maintain minute ventilation during apnoeic period with OPA or LMA.

Pre-treatment: Volume resuscitation with 20ml/kg crystalloid followed by peripheral inopressor (MAP 100 mmHg).

Plan: Slow is smooth, Smooth is fast. Most experienced operator. Ventilate through apnoeic phase. VL and bougie as plan A.

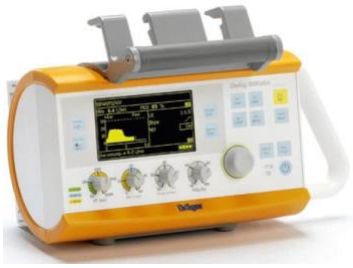
Paralysis & Induction: Low dose Ketamine + High dose Rocuronium.

Placement with proof: Waveform capnography and CXR.

Post-intubation care: Lung protective strategy. Consider SIMV-PC in severe metabolic acidosis. CVL + arterial line + IDC placement to titrate inopressors.

Equipment Fact of the Month:

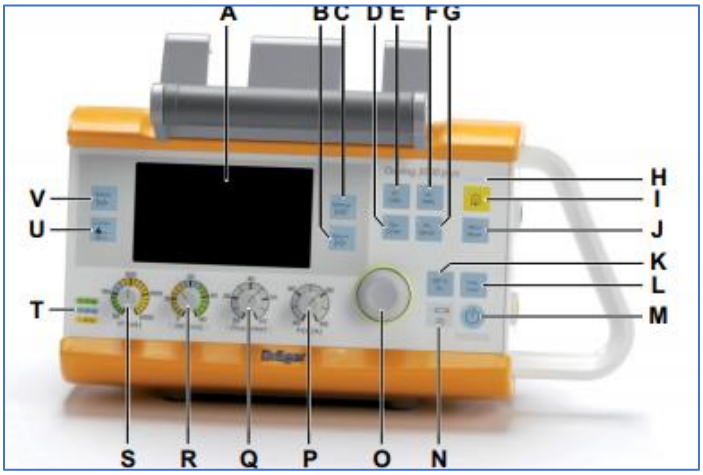
Drager Oxylog 3000 Emergency & Transport Ventilator



The Drager Oxylog emergency and transport ventilator was first developed in 1976, and since then has gone through several iterations, with the most recent being the Oxylog 3000 plus.

For emergency medicine providers, knowledge of the anatomy and connections of the Oxylog ventilator, in addition to ventilation modes, ventilator strategies, and troubleshooting high airway pressures, are essential.

Anatomy + Connections



A Screen
B Alarms
C Settings
D CPAP
E VC-CMV
F VC-SIMV
G PC-BIPAP
H Alarm indicators
I Silence Alarm
J Alarm Rest
K 100% O2

L Inspiratory Hold
M Start/Standby
N Power Supply
O Rotary Knob
P FiO2
Q Pmax
R Resp Rate
S Tidal Volume
T Colour coding
U Key curves
V Key Values

A Emergency Air Intake
B Fresh Gas intake
C Protection Bracket

A Emergency Air Intake
B Knob for Securing Battery Compartment Cover
C Connectors for Flow Measuring Lines
D Gas Outlet for Breathing Hose
E Connector for O2 Supply
F Connector for Power Supply
G Connector for CO2 Sensor
H Connector for Data Communication Cable

Modes for Oxylog 3000 plus

VC-CMV "Volume Controlled – Controlled Mandatory Ventilation"

- This mode gives a set number of preset breaths / minute at a set volume
- Does not allow for the patient to breathe spontaneously unless the trigger is set for a value that the patient achieves during their spontaneous respiratory effort (changes to VC – Assist Control mode)
- CMV setting only used for patients who are not taking spontaneous breaths

VC-SIMV "Volume Controlled – Synchronized Intermittent Mandatory Ventilation"

- This mode delivers a set number of preset breaths / minute at a set volume
- Allows for the patient to breathe spontaneously through mandatory breaths that are augmented by the ventilator
- Pressure support setting on this mode supplies the inspiratory pressure during spontaneous breaths
- ***Standard initial mode to use for ED patients who have undergone RSI***

Spn CPAP "Spontaneous Continuous Positive Airway Pressure"

- For spontaneously breathing patients
- Patient can breathe at the continuous positive pressure level, with or without pressure support

PC BIPAP "Pressure Controlled – Biphasic Positive Airway Pressure"

- Pressure controlled ventilation mode
- Patient can breathe spontaneously at any time, but the number of mandatory breaths is specified
- The tidal volume is achieved by setting the difference between PEEP and Pinsp
- Would be standard initial setting for patients who are undergoing NIV with the Oxylog – must switch on NIV in settings in order to facilitate this

Lung Protective Ventilator Strategy (Volume Controlled)

Indications: Patients with abnormal lungs, in the absence of asthma or COPD eg. Pneumonia, inhalational injury

Complications: Hypotension due to increased PEEP, barotrauma.

MODE	VT	RR	I:E	PMax	PEEP	PPlat
VC - SIMV	6mL/kg ideal body weight	18/min then titrate	1:1.5 (default)	40 mmHg	Initially 5 then titrate*	Less than 30

*PEEP titration as per lung protective ventilation strategy using FiO2/PEEP scale aiming for a SpO2 from 88-95% - From ARDSnet guidelines:

titrate using FiO_2/PEEP scale→SpO_2 of 88-95%

FiO_2	40	40	50	50	60	70	70	70	80	90
PEEP	5	8	8	10	10	10	12	14	14	14

Obstructive Ventilator Strategy (Volume Controlled)

Indications: Asthma and COPD – goal is to provide as much expiratory time as possible.

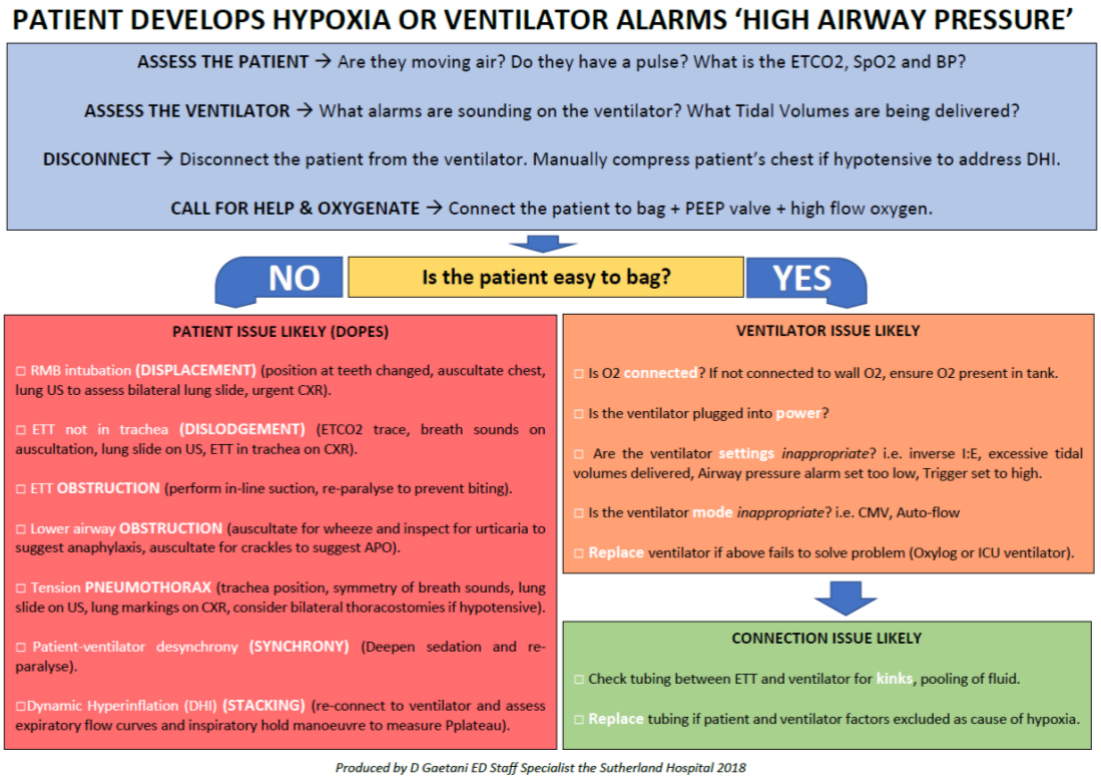
Complications: Gas trapping or Auto PEEP – the spontaneous development of PEEP due to insufficient expiratory time.

MODE	VT	RR	I:E	PMax	PEEP	PPlat
VC – SIMV	6mL/kg ideal body weight	10/min then titrate down if needed	1:4 or 1:5	40 mmHg	0	Less than 30

Other Ventilator Strategies

Obesity: Consider TV 8-10 mL/kg (in absence of obstructive lung disease or necessity of lung protective strategy) Start PEEP at 10cmH2O and titrate PEEP as per ideal body weight
Pregnancy: Left lateral position, TV 8mL/kg ideal body weight, RR 20-22, aim for low/normal pCO2
Metabolic acidosis: Commence RR greater than or equal to what patient achieved, aim for EtCO2 less than what patient achieved. Consider lightening sedation to allow for patient to add additional breaths as required. Gentle BVM ventilation during apnoeic phase.
Severe traumatic brain injury: Head up at 30 degrees (if not contraindicated), PEEP = 5 (too much PEEP can decrease cerebral perfusion pressure), aim for pCO2 from 35-40 mmHg

Troubleshooting



Word on the Street:

Pre-oxygenation strategies outside the operating theatre

(A/Prof Holdgate is one of the co-authors)

Groombridge, C., Chin, C.W., Hanrahan, B. & Holdgate, A. (2016). 'Assessment of common preoxygenation strategies outside of the operating room.' *Academic Emergency Medicine 23(3):342 – 346*.

Bottom-line: In healthy volunteers, the effectiveness of BVM pre-oxygenation was comparable to the anaesthetic circuit (criterion standard) and superior to pre-oxygenation with NRM. The addition of NC oxygen, PEEP, or both did not improve the efficacy of the BVM device.

Academic Emergency Medicine
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ORIGINAL CONTRIBUTION

Assessment of Common Preoxygenation Strategies Outside of the Operating Room Environment

Christopher Groombridge, MBBS, FACEM, Cheau Wern Chin, MBBS, Bernard Hanrahan, MBBS, FANZCA, and Anna Holdgate, MBBS, FACEM

Abstract

Objectives: Preoxygenation prior to intubation aims to increase the duration of safe apnea by causing denitrogenation of the functional residual capacity, replacing this volume with a reservoir of oxygen. In the operating room (OR) the criterion standard for preoxygenation is an anesthetic circuit and well-fitting face mask, which provide a high fractional inspired oxygen concentration (FiO_2). Outside of the OR, various strategies exist to provide preoxygenation. The objective was to evaluate the effectiveness of commonly used preoxygenation strategies outside of the OR environment.

Methods: This was a prospective randomized unblinded study of 30 healthy staff volunteers from a major trauma center emergency department (ED) in Sydney, Australia. The main outcome measure is fractional expired oxygen concentration (FeO_2) measured after a 3-minute period of tidal volume breathing with seven different preoxygenation strategies.

Results: The mean FeO_2 achieved with the anesthetic circuit was 81.0% (95% confidence interval [CI] = 78.3% to 83.6%), bag-valve-mask (BVM) 80.1% (95% CI = 76.5% to 83.6%), BVM with nasal cannula (NC) 74.8% (95% CI = 72.0% to 77.6%), BVM with positive end-expiratory pressure valve (PEEP) 78.9% (95% CI = 75.4% to 82.3%), BVM + NC + PEEP 75.5% (95% CI = 72.2% to 78.9%), nonrebreather mask (NRM) 51.6% (95% CI = 48.8% to 54.4%), and NRM + NC 57.1% (95% CI = 52.9% to 61.2%). Preoxygenation efficacy with BVM strategies was significantly greater than NRM strategies ($p < 0.01$) and noninferior to the anesthetic circuit.

Conclusions: In healthy volunteers, the effectiveness of BVM preoxygenation was comparable to the anesthetic circuit (criterion standard) and superior to preoxygenation with NRM. The addition of NC oxygen, PEEP, or both did not improve the efficacy of the BVM device.

ACADEMIC EMERGENCY MEDICINE 2016;23:342–346

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